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INTO AN ORGANIZATION:

STRUCTURED METHODS FOR PRODUCING

COMPUTER SOFTWARE

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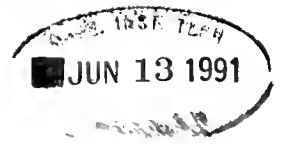CISR No. 103

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Introducing Production Innovation Into an Organization:

Structured Methods for Producing Computer Software

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Introduction

Introducing a significant process innovation into an organization could be likened to guiding a group of hikers through an unfriendly jungle. Someone has to lead; there has to be some level of agreement that the destination is worth reaching; all sorts of pitfalls must be avoided enroute, and the success of the venture is judged not only by whether the party members reach their goal, but also by the state of their health when they get there.

To a large extent, organizational innovation does not differ from innovation in the general marketplace. Widespread adoption of an innovation in an organization depends upon many individual adoption decisions, each of which is subject to some of the same influences as any new product purchase decision. However, the very fact that the individual decision to use or not use an innovation is made in the organizational context, introduces an entire set of influences which are not usually present outside that context.

The introduction of a new process innovation, that is, a new way of making organizational products, is fraught with challenges beyond those attending most

product innovation.[1] By definition, a process innovation is part of an interdependent production system. The initial adoption decision is usually made by managers, out of a hope for organization-wide benefits such as increased efficiency through standardization, or better productivity. Therefore, the decision to innovate in production techniques is more likely to be authoritative than participative, with some of the attendent difficulties of a top-down decision (Rogers and Agarwala-Rogers, 1976).

While the manager controls the adoption decision, the successful implementation of that decision is often dependent upon actors much further down in the hierarchy -- especially the operators of the innovative equipment or process. These innovation users always have to "buy in" to the decision to some degree, else there will be severe problems, including, at best, non-use and at worst, sabotage of the technology (see Keen, 1978; Dowling, 1979). The more latitude there is in use of the innovation and in the policies of the organization governing that use, the more that the individual user's adoption decision whether or not to utilize the innovation approximates an independent adoption decision based on an evaluation of the potential benefits to be derived from the new technology. Thus, the manager is the first adopter, but then there are hundreds (sometimes thousands) of secondary adopters, upon whom successful diffusion depends. This paper focuses on the decisions of these secondary adopters, the innovation users, rather than on the original management decision-maker.

Probably the greatest difference between the diffusion of process and of product innovations is that these prospective adopters of production innovations

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[1]Of course, one person's process is another person's product. The distinction is often blurred. For the purposes of this paper, process innovation is a new way of (structured methodologies) of making a product (software). An important characteristic distinguishing process from product innovation is the intermediary position of the adopter, who stands between the developers of the innovative process and the end-users of the product made with that process.

are people in the middle, subject to pressures from both upstream (management) and downstream (clients). These "secondary" adopters have not one, but three sets of criteria to satisfy: their own, their manager's and their client's. While a product innovation may be accepted because it is intrinsically more satisfying to use or technically superior to whatever it replaces, the relative advantage of a process innovation usually lies in the adopter's enhanced ability to produce a superior product and thus to please both managers and customers.

The Model

Figure 1 presents in diagramatic form a general framework which the author finds useful in studying the introduction of technological change into a firm. Each of the linkages pictured in Figure 1 is important in determining the success of a production innovation. The major assumption underlying the diagram and the analysis which it engenders, is that use of a process innovation (i.e., the successful implementation of a managerial decision to innovate in production processes) depends on the degree to which each set of variables characterized by boxes A through E is congruent with each other set. The importance of some of these relationships has been well established in the marketing or the diffusion of innovations literature. Other relationships have been slighted in the traditional research and need to be tested empirically. The study described in this paper covers all of the pictured relationships, albeit to varying degrees. Before that study is described, however, a very brief review is provided of some of the major generalizations which can be made about the relationships pictured in Figure 1, based on academic research.

Relationship A-B, between the advantages of and need for, a technological innovation and the personal goals and rewards of the adopting individual has been well explored in the literature on marketing and on the diffusion of innovations. Obviously, the new product or process to be introduced should have a clear advantage for prospective users over whatever is to be supplanted. Furthermore,

FIGURE 1

Lines of Potential Interdependence in the Diffusion
of Technological Innovations
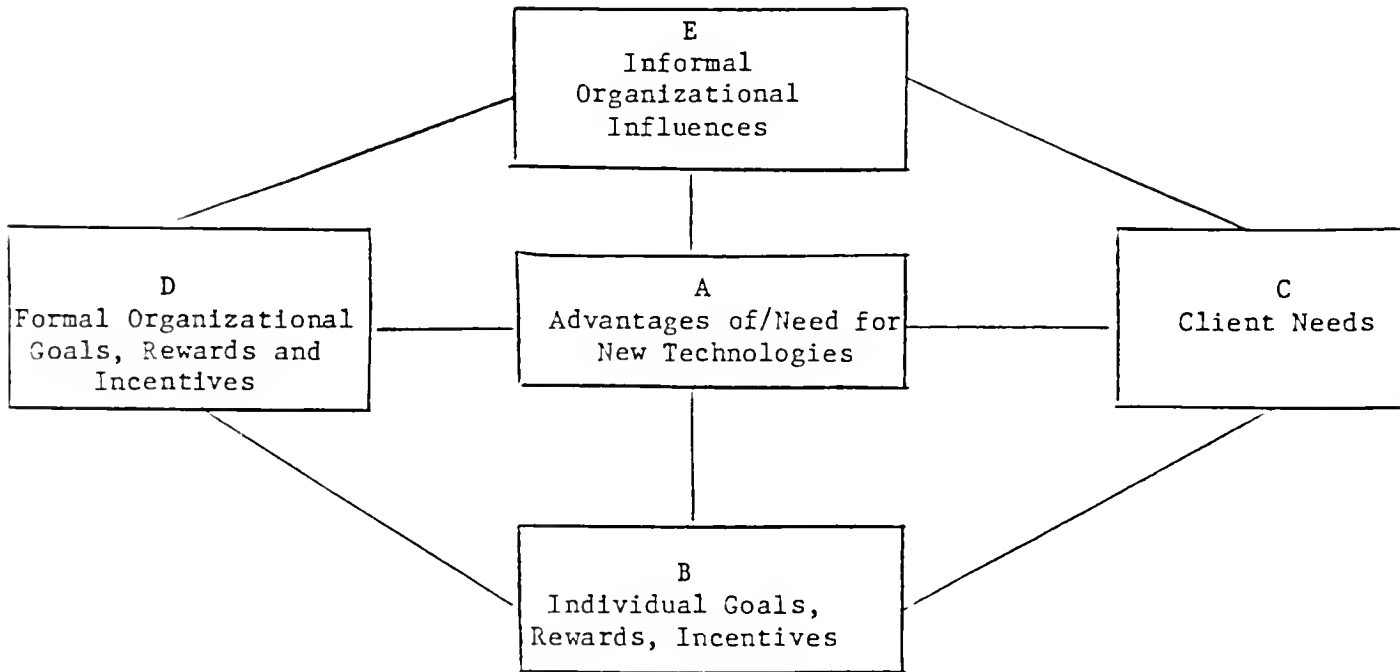
the less complex the innovation and the more compatible it is with the potential adopter's values, the more likely the new product or process is to succeed (Rogers, 1982). In other words, the more congruence existing between the attributes offered by the work innovation and the set of personal values, skills and job-related satisfactions possessed by the individual, the more attractive the technology.

Linkage A-C between the innovation advantages and the needs of clients is likewise of obvious importance. The clients, or end-beneficiaries of a process innovation may be tertiary, and unwitting, adopters. That is , they may never directly evaluate the technology. They may not even be aware that a new process has been introduced into the construction of the end product they receive (see Leonard-Barton, 1983a). However, as noted before, workers in the production process have to be aware of the extent to which the new technologies help them produce a product which satisfies client needs. Literature on new product development supports the perception that innovative processes need to satisfy market requirements (the market, in this case, being the client receiving the end product). Products pulled into existence by market needs succeed more than those propelled into the world by the sheer momentum of technological advance (Marquis, 1969; Freeman et al, 1972).

Informal organizational influences (Box E) includes the power of communication networks or of corporate "culture" to circumvent or support organizational goals (Link E-D) and the importance of "shadow" organizational hierarchies, i.e., informally determined roles, in the acceptance or rejection of new technologies (relationship E-A). For instance, a set of informally recognized but powerful expectations which run counter to the formal organizational reward system are unlikely to be fulfilled.[2] However, when informal influences

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[2]Steven Kerr in his perceptive article about "The Folly of Rewarding A While Hoping for B." notes a number of such inconsistencies, such as the policy of universities to expect excellent teaching but to formally reward only research.

1) reinforce organizational goals or 2) impact perceptions of the value of a technology, the informal structures importantly affect the diffusion of an innovation. An example of the former is the case of a dynamic leader who inspires people to commit to unusual work loads or who "champions" an entrepreneurial venture (Maidique, 1980). Instances of the latter include cases in which favorable information supporting the need for or advantages of, an innovation foster its diffusion while negative sources of information serve as focal points for the dismissal of a new product or process. Market rather than organizational settings provide most of the research evidence on the relationship E-A, both positive (e.g., Arndt, 1967, Whyte, 1954, or Leonard-Barton, 1983, on the innovation-encouraging effects of positive word-of-mouth and opinion leadership) and negative (e.g., Midgley, 1977; Technical Assistance Research Programs, 1981, Richins, 1983 and Leonard-Barton, 1983 on the inhibiting effects of negative word-of-mouth and negative opinion leaders).

Moreover, the literature on organizational behavior has recently begun to emphasize the overall importance of goal congruence among organizational members and elements. (See, for instance, Nadler and Tushman, 1980).

The study setting described below offered an opportunity to examine all of the relationships pictured in Figure 1 and hypothesized, on the basis of previous research, to be of importance in the diffusion of a process innovation. As noted before, the study focuses on the individual user-adopter as the unit of analysis; therefore, all the relationships are examined through the screen of those adopters' perceptions, not as a set of independently measured relationships. However, perceptions, not reality (presuming there is such a thing as an objectively determined reality) govern peoples' actions. What this study attempts to accomplish is the examination of numerous, very different influences on the attitudes and use by organizational members of a production innovation.

Research Setting

The opportunity to conduct the study arose because a major U.S.-based firm wished to identify major barriers slowing the diffusion of several process innovations in which this corporation (hereafter referred to as VLC) had invested much time, money and staff support. The innovations are methodologies designed to provide a structured, standardized approach to the construction of computer software. The motivation behind the innovation was a need for greater productivity; VLC, like many of its counterparts, expends tremendous resources on the development, enhancement and maintenance of computer software to support their internal operations, e.g., administration, finance, engineering, production. As is now generally recognized, software, not hardware, sets the limits to use of computers in business.[3] The construction of software has traditionally been an individual craft rather than a standardized production procedure, with the result that it is difficult for one person to enhance or maintain another's highly individualistic piece of work.[4] The assumption behind the development of the engineering approach to software construction is that standardization will lead to greater efficiency by enabling programmer/analysts to "hand-off" programs or even modules within programs, to each other, since everyone will use the same approach.[5] Acting on this assumption, VLC has set out guidelines for their thousands of programmer/analysts world-wide, which specifically require the use of the methodologies for given system development tasks.

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[3] Computer software costs usually contribute at least 65-75% of the total system cost (Datapro, 1976).

[4] Organizations can expect to spend 50% or more of their annual data processing budgets on maintaining previously written programs (Brooks, 1975).

[5] It should be noted at the outset that VLC has not even tried and other corporations using similar approaches, have not been able to prove that in fact, these methodologies enhance productivity. The applications, tools, and methodologies are changing so rapidly that only a high cost, controlled experiment could establish the value of the structured approach.

However, there are no actual sanctions for not using the methodologies, and in fact, no formal way of checking whether they are used or not. Therefore, although the corporate management has clearly signaled their desire that the methodologies be used, in practice, analyst groups have considerable freedom to choose.

The Innovations

Five innovations were studied, but for the purposes of this paper, discussion is confined to one of the two most prevalent and recently introduced methodologies: Structured Systems Analysis (hereafter SSA). It was developed by a corporate group, at corporate headquarters, for dissemination to and use by, analysts in multiple sites around the world. SSA is the first methodology to be applied by analysts in building a system. Following this methodology (which is set out in books), the programmer/analyst constructs a diagramatic flow model of the client's business, and of information flows through that business (e.g., customer orders and service or factory production lines). SSA, its developers feel, provides an effective communication mechanism (diagrams) for identifying client needs, objectives, and limitations. This early design phase is extremely critical since errors in requirements definition are highly expensive. The notation used is consistent with the other, downstream methodologies used to guide the production of simple, maintainable code.

Research Sample and Methods

The research was conducted in three phases, moving from unstructured interviews with the innovation developers and potential or actual users at corporate headquarters (N=20), through the testing on a group of about 25 analysts at corporate headquarters of semi-structured and highly structured questionnaires, to a final three-site survey. The three sites were: 1) Corporate Headquarters, (N=28); 2) a U.S. based affiliate, (N=56); 3) an international affiliate, (N=61). Although analysis has revealed a few site-specific differences among the

populations studied, measures of most of the key variables seem to be site-independent. Therefore, the analysis in this paper is based on the personal interviews with all 145 programmer/analysts, including some supervisors and analysts whose primary responsibilities are project management rather than code generation. Table 1 lists the operational variables implied by the model presented in Figure 1.

Findings

The use or nonuse of the particular set of innovations studied here is extremely difficult to measure, for a number of reasons. First, each methodology is particularly applicable to a certain set of tasks; assignments among analysts differ. An analyst who is concerned mostly with the maintenance of software developed years ago, for instance, would have little occasion to use SSA, while an analyst whose expertise lies principally in scoping out large systems might have the chance to use SSA literally every day. Therefore, task assignment determines opportunity to use the methodologies.

Furthermore, despite the guidelines, there is no universal agreement as to when the methodologies are applicable to a given task. Naturally, the methods developers see a much wider range of possible applications than do the analysts.[6] Furthermore, for some variables, responses only make sense if the respondents have in fact, some experiential (rather than merely attitudinal) basis for making a judgment, i.e., they have received formal or informal training in the methodology.

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[6]To ensure that the dependent variable is sensitive to these nuances, usage is measured as a function of task assignment. Usage on each methodology is measured only for those analysts who have had some occasion to perform the relevant tasks.

In addition, each respondent was asked to state what alternatives were employed in completing the tasks, so that it is possible to determine whether a response of "not applicable" refers to lack of opportunity for use or a judgement about the relevance of the methodology.

TABLE 1

Variables Influencing the Diffusion of
Technological Innovations Within Organizations

A	B	C	D	E
The New Technologies	Individual Goals, Rewards, Incentives	Client Needs	Formal Organizational Goals, Rewards, Incentives	Informal Organizational Influences
- Access - Attributes	- Demographics (Age, Education, etc.) - Technical skills - Experience in the field - Personal goals (managerial or technical career) - Attitudes towards this generic type of technology - Attitudes towards these specific technologies	- Desired product characteristics - Constraints on technology use (budgets, etc.)	- Values placed on technology - Supervisor's desires - Promotion criteria - Guidelines for use of technology	- Relations/Communication with technology originators - History of technology - Presence/Absence of technology advocates - Negative opinion leaders

Correlates/Predictors of Usage

Individual Goals, Rewards, Incentives

The programmer/analyst position at VLC is an entry-level position, from which employees may progress up either the technical or the managerial "ladders", i.e., either continue to perform technical work, but at an ever-increasing level of sophistication, or gradually assume more and more responsibility for the management of technical projects. Consequently, analysts tend to be quite young (over half are under 30). Many (two-fifths) have technical computer training at an undergraduate or masters' degree level. Most bring to the job, skills in various programming languages and sometimes even other structured methodologies.

Since age is frequently associated with resistance to innovation, it is a possible predictor of usage. However, as noted above, there is little variation in age among analysts. Moreover (although the range is compressed) there is a positive, not negative, relationship between age and SSA use (Pearson Correlation Coefficient = .17; significance = .02). Older analysts (even controlling for position in the organization) are somewhat more, rather than less, likely to use SSA. The correlation is not a strong one, however.

Educational background, on the other hand, relates strongly to usage. As Table 2A shows, technically-trained people are much less likely to use SSA than are their colleagues who did not graduate with degrees in computer science. However, the reason for this finding, as Table 2B suggests, is that programmer/analysts with a computer science background are not being trained in the methodology[7]. As Table 2B shows, once respondents who have not received training SSA are excluded from the analysis, there is no relationship between education and use of the methodology.

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[7] It is not clear whether this apparent bias occurs because analysts with a computer science background do not choose to be trained or because their supervisors do not send them to training, on the assumption that they need it less than analysts educated in non-computer related fields.

TABLE 2.

Relationship Between Type of

Education and Use of SSA

A.

	Computer Education[a]	Non-Computer Education[b]	
Usage of SSA[c]			
None	23 (57.5)	12 (21.8)	35
Use[c]	17 (42.5)	43 (78.2)	60
	40 (100.0)	55 (100.0)	95 100.0

Corrected Chi Square = 11.18, with 1 D.F. Significance Level, p. = .0008

B.

	Computer Education[a,d]	Non-Computer Education[b,d]	
None	12 (60.0)	28 (59.6)	40
Use[c]	8 (40.0)	19 (40.4)	27
	20 (100.0)	47 (100.0)	67 100.0

Corrected Chi Square = .000, with 1 D.F. Significance Level, p. = 1.00

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[a]Respondents with a B.S. or M.S. in computer science

[b]Respondents with a B.A. or M.A. in non-computer-related fields.

[c]Includes both light and heavy users.

[d]Excluding respondents who have had no training in SSA.

Regardless of education, however, respondents who expect to be engaged principally in technical work in the future are less likely to use SSA now than those aiming at a managerial career (Table 3). Respondents were asked what kind of job they expected to have five years from now, and what kind of career they intended to pursue. The responses to both questions showed a split between SSA users and non-users, with the future managers being the users.

Since differences of opinion exist about the wisdom and feasibility of moving software production from an art form into a standardized, engineering process, one would expect that SSA users have a more favorable opinion towards the structured approach in general and towards this structured method in particular, than do non-users.[8] A five-item scale (alpha = .58) set up to measure attitudes towards structured systems development as a concept confirms this expectation by relating positively to usage (Chi square = 7.52 with 2 D.F.; significance level p. = .02). Moveover, as expected, positive attitudes towards this particular project to develop structured methodologies (as measured on a six-item scale; alpha = .60) also relate positively to their use (Chi square = 10.85 with 2 D.F.; significance level p. = .004).

Next, it is important to examine (from the perspective of the analysts who provided the data) the linkages of client needs with the advantages of the new technologies (relationship A-C in Figure 1) and of client needs with the rewards, incentives and goals experienced by individual analysts (relationship C-B).

Like most professionals possessed of specialized knowledge, system development programmer/analysts know their clients are unable to judge the merits of a new process innovation (except as it is reflected in final product), and clients are often totally unaware that innovations have been introduced into the construction

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[8]Of course, no causality can be assigned here. It is plausible that users rationalize their adoption and use of the methodologies by assuming positive attitudes towards structured methodologies in general. Indeed, the attributionists among psychologists would explain the relationship this way. (Bem, 1967).

TABLE 3.

Usage of SSA According to Whether

Analysts Intend to Pursue a Technical

or Managerial Career[a]

Career Path

	Managerial	Technical	
Use of SSA			
No Use	9 (17.3)	14 (46.7)	23
Some Use	19 (36.5)	11 (36.7)	30
Heavy Use	24 (46.2)	5 (16.7)	
	52 (100.0)	30 (100.0)	82 (100.0)

Chi Square = 10.52, with 2 D.F. Significance level p. = .005

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[a]Controlling for training; i.e., these data are collected from analysts who have had training in SSA.

of the product they receive; (Leonard-Barton, 1983). In our survey, about half of the respondents felt it unimportant that a client know how a program works, "as long as it does the job;" 60 percent said that client users "don't really want to know how a program works," and less than 20 percent felt that clients appreciated the work done more if and when the new methodologies were used to produce it. In short, many respondents doubted that a direct assessment by clients of the need for and advantages of the new methodologies (linkage C-A) was important. However, those respondents who scored above the average on a three-item scale measuring perceptions about the extent of client interest in the methodology (constructed from the items cited above; alpha = .58) were in fact, much more likely to use SSA than were those who fell below the mean on the scale (see Table 4). Again, of course, this relationship could represent users' post-adoption rationalization about reasons for use rather than a perceived need which was driving adoption. Either way, those individuals who perceived congruence between client needs and the advantages of the innovations were more likely to use the innovations than those who did not.

Even more important however, from the individual analysts' point of view, is the relationship between the individual's incentives to produce a product with particular characteristics, and the client's needs. Analysts were asked to rank the top three out of ten possible attributes[9] which might characterize any given systems development project, according to what they themselves regarded as the three critical characteristics, what they felt their clients would rank most highly, then according to what their supervisors and what top management would consider to constitute a job well done. As Table 5 shows, three characteristics were regarded by analysts as generally important to everyone: 1) completed on time; 2) designed to user specification; and 3) providing accurate solution. However, when weighted

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[9]The ten were derived from the in-depth unstructured interviews in Phase One as described above.

TABLE 4.

Relationship Between Respondents' Perceptions
of Client Desires and Usage of SSA

Respondent Scores on Scale Measuring Client
Awareness of and Desire For Structured Techniques

Use of SSA	Below Average	Above Average	
No Use	16 (69.6)	7 (30.4)	23
Some Use	14 (46.7)	16 (53.3)	30
Heavy Use	10 (33.3)	20 (66.7)	30
	40 (100.0)	43 (100.0)	83 (100.0)

Chi Square = 6.89, with 2 D.F. Significance level p. = .03

rankings for the four groups are compared, all are significantly different except
for the analysts' perception of their own ranking compared with their clients' on
two characteristics: 1) completed on time; and 2) designed to user
specifications. On these two attributes, the analysts felt their own opinion
coincided with their clients'. The most highly significant differences occurred
between the analysts and clients on the one hand and supervisors and top management
on the other. From the analysts' perspective, management cares almost exclusively
about having projects brought in on time and, of paramount importance, on budget.

Evidently, then, analysts feel some tension in relationship B-D in Figure 1:
the contrast between their own personal goals for a project (which they perceive as
being closer to their clients' than to their supervisor's and to top management's)
and the project goals of management.

What about relationship B-A-D, the use of the technologies to accomplish
management-set goals and objectives? It is interesting to note in this context
what analysts considered to be the major advantages and disadvantages of the new
methodology. As Table 6 shows, the major advantages of SSA are ones which would
aid an analyst in providing a more accurate solution and in designing to user
specifications. At first glance, there is no apparent barrier to the use of the
new methodology. However, as Table 6 also indicates, the principal disadvantages
to the use of SSA (aside from a lack of familiarity with it and therefore the
costly necessity of learning something new) is that it is too time-consuming to use
and too expensive for the budget.[10] Since, as noted above, analysts are keenly
aware of time and budget as the primary criteria for success in the eyes of
supervisors and management, the fact that SSA requires an up-front investment by
the client and the analyst in analyzing the business in a structured fashion would
seem to constitute a serous impediment to use.

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[10] Since analysts charge their time to a given project, these two are related.
However, they are not identical.

TABLE 5.

Analysts' Perceptions of Product Characteristics
Most Valued by Them, by Their Clients, by Their Supervisors, and by Top Management   (N = 145)

Product Characteristics	Analysts			Clients			Supervisors			Top Management		
	Number[a]	Weighted Average[b]	Ranking[c]	Number[a]	Weighted Average[b]	Ranking[c]	Number[a]	Weighted Average[b]	Ranking[c]	Number[a]	Weighted Average[b]	Ranking[c]
Completed on time	4	5.2[d]	3	20	4.6[d]	4	48	2.9	1	23	3.6	2
Within budget	4	5.8	6	12	4.8	5	46	2.8	2	76	2.0	1
Designed to user specifications	50	3.7[d]	2	56	3.3[d]	1	21	4.9	3	15	5.2	3
Accurate solution	58	3.8	1	29	4.5	2	19	5.4	4	13	5.6	4
Good communication with user	7	5.8	7	10	6.0	6	0	6.4		4	6.2	6
Clearly documented	0	6.4		0	6.6	7	2	6.2	5	1	6.7	
Easily enhanced	0	6.7		1	6.8		0	6.9		0	6.9	
Easily maintained	5	5.6	5	0	6.8		2	6.3	7	2	6.3	7
Meets organizational guidelines, standards	0	6.6		0	7.0		4	6.3	6	8	5.6	5
Easily run by user	10	5.5	4	17	4.5	3	2	6.8		1	6.8	
Other (written in)	4	6.8		1	6.9		0	6.9		1	6.9	
Missing Data	1			1			1			1		
Total	145			145			145			145		

[a] Number of analysts who ranked this product characteristic as most important to this group of individuals (e.g., Clients, Supervisors) in evaluating the product.

[b] This figure was obtained by weighting responses according to their ranking in importance by each respondent (the most important characteristic was weighted by 1, the second by 2, the third by 3, and "not selected" by 7), then totalling and averaging the weighted responses. The potential range is therefore 1-7. The smaller the number the more important the characteristic.

[c] Based on average weighted rankings.

[d] Weighted rankings not significantly different between analysts and clients at the p < .01 level.
All other mean rankings are significantly different.

TABLE 6.

Principal Advantages and Disadvantages of SAS,
According to Analysts (N = 145)

	SAS Advantages	Weighted Rankings[a]		SAS Disadvantages	Weighted Rankings[a]
1.	Helps me understand client's business	3.7	1.	Unfamiliar	2.2
2.	Is a structured approach	4.7	2.	Time-consumng to use	3.0
3.	Improves requirement definition	4.9	3.	Too expensive for client (time and budget)	5.6
4.	Provides improved communication	5.6	4.	Not oriented to my application	5.8
			5.	Not useful for maintenance	5.9

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[a]Respondents were asked to select and record in ranked order, the three most important advantages and disadvantages of each methodology. Responses were weighted by their rank order (e.g., third ranked = 3); reponses not selected were arbitrarily assigned the average ranking of 8 for advantages and 7 for disavantages, on the assumption that responses not selected, if ranked, would be randomly distributed among all possible remaining rankings (i.e., 4 to 12 for advantages, 4 to 11 for disadvantages). The rankings were then aggregated and averaged. The smaller the number shown in the table, the higher the rank, or average, given to this response.

These findings lead logically to the question: If an analyst believes that the use of SSA is costly in terms of time and of budget and he/she also believes that there is pressure from clients or management to be on time and within budget, is that analyst less likely to use SSA?

The answer, as Table 7 shows, is mixed. There is no evidence that the fact SSA requires time is, in and of itself, a barrier to use. What little relationship exists between the variable, awareness of conflict between product attributes and management goals, and the usage variable, appears to be positive, but the chi square is not significant. The reason for this finding is probably that being on time is not a goal directly threatened by SSA. That is, a systems development method can be time-consuming without causing one to run over the allotted time. The project will be more expensive, the longer it goes, but the amount of time needed for a given project can be miscalculated, whether one uses time-consuming technologies or not.

The variable shown in Table 7, which measures conflict in goals (i.e., SSA takes time and being on time is a top goal) combines responses referring to the analyst, the client, the supervisor and top management. If each category is singled out for separate analysis, there is a strong positive relationship between use of SSA and the analysts' belief that the client wants the project done on time but SSA is time-consuming (Chi square 10.25 with 2 D.F.; significance level, p. = .006). This seems contradictory; however, evidently, SSA users are highly sensitive to the fact that SSA takes longer. This awareness is unaffected by the pressure from clients to get the job done on time.

Clients' concerns about budget are more influential (see Table 8). The more that an analyst feels cost is a disadvantage of SSA and also believes budget is a primary concern, the less likely that analyst is to use SSA heavily. As Table 8 shows, the measure combining all responses (for the analyst, client, supervisor and top management) is negatively related to usage (significant at the p. = .07 level).

TABLE 7.

Relationship Between Use of SSA and Analysts'
Perceptions that SSA is Time-Consuming But
Time is Important

Use of SSA	No Perceived Conflict[a]	SSA is Time-Consuming and Time is Important[b]	
No Use	25 (49.0)	20 (33.3)	45
Some Use	14 (27.5)	21 (35.0)	35
Heavy Use	12 (23.5)	19 (31.7)	31
	51 (100.0)	60 (100.00	111

Chi Square = 2.83, with 2 D.F. Significance level, p. = .24

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[a]These respondents do not satisfy both conditions, i.e., do not believe SSA is time-consuming and/or did not believe time is important in evaluation of a job.

[b]These respondents both believe SSA is very time-consuming and that time is very important (to themselves, their clients, their supervisors, top management or to more than one of these groups).

TABLE 8.

Relationship Between Use of SSA and Analysts'
Perceptions that SSA is Costly But Staying
Within Budget is Important

Use of SSA	No Perceived Conflict[a]	SSA is Costly and Staying Within Budget is very Important	
No Use	34 (17.3)	11 (46.7)	45
Some Use	20 (25.3)	15 (46.9)	35
Heavy Use	25 (31.6)	6 (18.8)	31
	79 (100.0)	32 (100.0)	111

Chi Square = 5.13, with 2 D.F. Significance level, p. = .07

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[a]These respondents do not satisfy both conditions, i.e., do not believe SSA is costly and/or do not believe staying within the budget is a primary concern.

[b]These respondents both believe SSA is very costly and that staying within budget is very important (to themselves, their clients, their supervisors, top management, or to more than one of these groups).

However, once again, the relationship is considerably stronger if the client is the source of pressure to stay within the budget (Chi square = 6.79, with 2 D.F.; significance level, p. = .03).

In summary, there are some perceived conflicts in relationships B-A-D and B-A-C. The methodologies cost time and money. The first disadvantage is not serious; analysts can simply allot more time; the second disadvantage is more serious, especially when the client is the one pressuring the analyst to stay within budget. Since a reputation for staying within a budget is important in securing promotion, the threat of budget overruns is a potent one.

The technology developers and potential users alike see the up-front investment in SSA as a problem, in that it is difficult to demonstrate the value of an investment now when the potential payoffs (easier maintenance and more efficient enhancements) are so far in the future. Moreover, easy maintenance is very low on everyone's list of important attributes, according to the analysts (See table 5). Apparently, no one is interested in paying now for a long-term life-cycle benefit. The only payoffs which appeal to the analysts are the immediate ones of improved communication and a better product, i.e., one which is more responsive to client needs.

There are other, more direct measures of the extent to which the organization encourages the use of SSA (link D-A). Respondent users of SSA scored high on a four-item scale (alpha = .55) set up to measure the analysts' perception of organizational values supporting the use of the new technologies (e.g., that good programming is rewarded and quality of work desired over quantity)(Chi square = 8.97 with 2 D.F.; significance level, p. = .01) . However, one individual item in that scale discriminates especially well between users and non-users. If an analyst's supervisor for the past 12 months wanted the analyst to use SSA, he/she was much more likely to do so than fellow analysts without this organizational prod. (See Table 9).

TABLE 9.

Effects of Supervisor's Desires on SSA Usage Levels

	Mean Usage[d]	T Value	Significance Level
I. Group[a] whose Supervisor wanted them to use SAS[b]	2.81		
		6.03	.000
Group[a] whose Supervisor did not necessarily want them to use SAS[c]	1.53		

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[a]Group determined by respondents' agreement or disagreement with the statement: "My supervisor would have liked me to use SAS."

[b]Defined as responses 4 or 5 on a five-point scale (61 cases) where 1 = Strongly Disagree and 5 = Strongly Agree with the statement in note a above.

[c]Defined as responses 1, 2, or 3 on a five-point scale (70 cases).

[d]Usage of SAS where 1 = Never and 5 = Always.

Not only formal encouragement makes a difference, however. Those analysts who know an advocate for SSA are more likely to use SSA than their colleagues who know no such enthusiast; (relationship E-A in Figure 1; see Table 10). Presumably, such an advocate not only serves as a role model and peer consultant but also actively persuades people that the extra time involved in using SSA is worth the effort.

Conclusions

Figure 2 summarizes the evidence on those relationships which aid and hinder the diffusion of this production innovation. If the management of VLC is committed to the promotion of this innovaton, the aiding relationships (e.g., presence of product advocates) must be enhanced, and hindering relationships must be altered. For instance, the fact that technically-educated analysts are not being trained to use SSA must be further investigated. Perhaps their alternative ways of "scoping out" projects are actually superior to the innovation, SSA.

Frequently, the managers in an organization introduce an innovation without analyzing how the current control systems stimulate or impede the diffusion of that innovation. In the case of VLC, for instance, it may be necessary to provide some method of life-cycle costing for systems development work, so that clients will see the benefits of their up-front investments in SSA, and therefore be willing to enlarge the budget. It would also seem that the analysts might be more interested in using SSA if they believed that they were being judged by management at least as much on the quality of their work, as on their adherence to budget.

As this case illustrates, the introduction of a process innovation into an organization is extremely complex. The manager introducing change must not only consider likely responses of the individual user to the innovation but also the way that existing organizational values and incentives operate relative to the innovation. Are the technical advantages of the innovation ones which lead to

FIGURE 2.

Relationships in the Diffusion of SAS which are Congruent (+) or Conflicting (−)
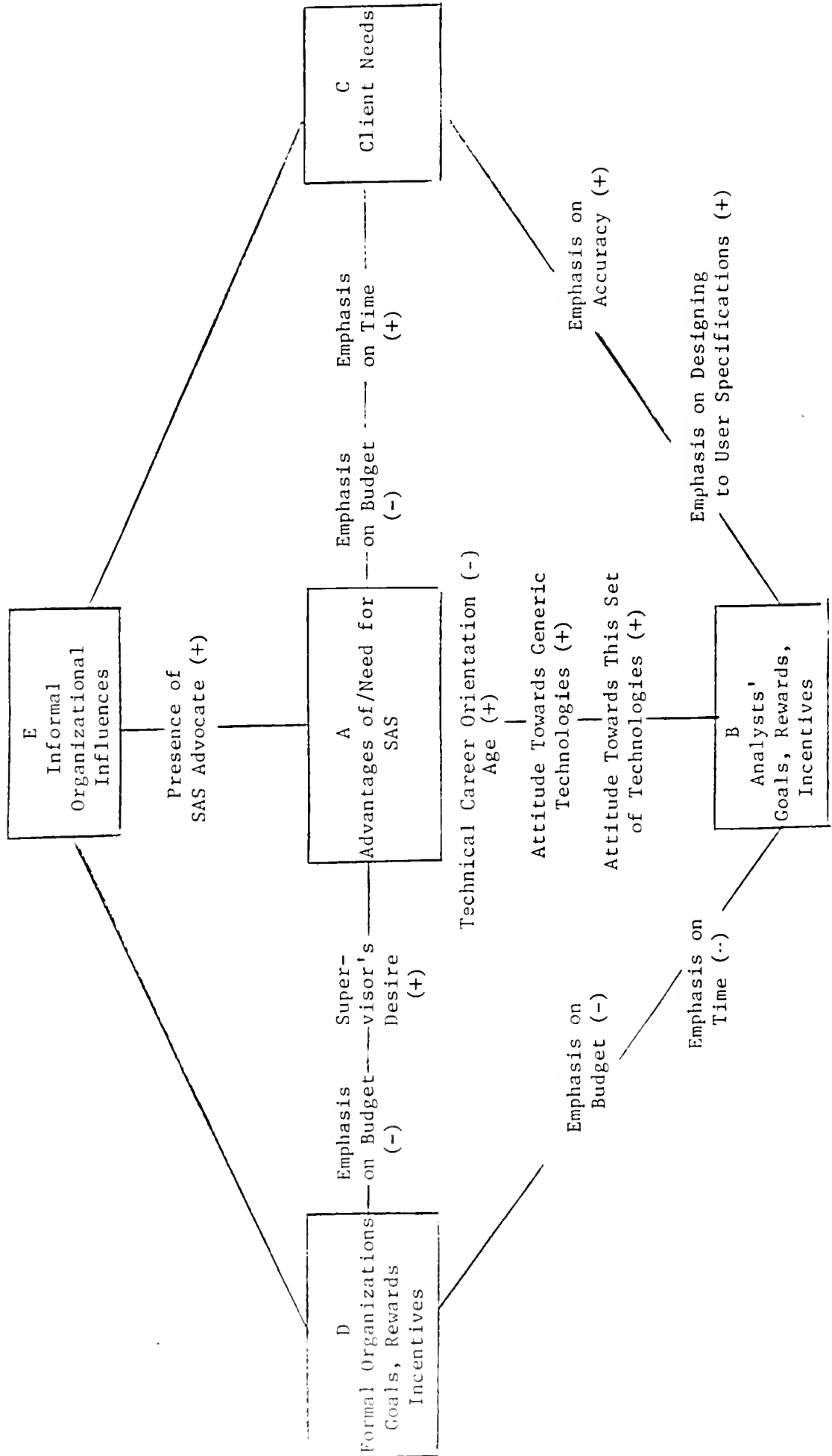
TABLE 10.

Differences in SAS Usage Levels Between
Groups Knowing or Not Knowing
a Product Advocate[a]

		Mean Usage[b] Level	T Value	Significance Level
I.	SAS Structured Systems Analysis			
	(a) Group knowing advocate	2.65		
			5.42	.000
	(b) Group not knowing advocate	1.47		

---

[a]Respondents were asked directly if they knew an advocate for each methodology.

[b]Usage of methodology where 1 = Never and 5 = Always.

product performance rewarded by the organization or are the characteristics of the

new technology at variance with the way products are evaluated? Is the innovation

likely to be valued by clients, by the end-users of the product produced with this

new method? No new process is introduced into a vacuum. Therefore, much

consideration must be given to the context into which it is introduced and to

interactions within that context.

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